UMATILLA RIVER BASIN ANADROMOUS FISH HABITAT ENHANCEMENT PROJECT

I99 1 Annual Report

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ABSTRACT

The Umatilla habitat improvement program is funded under the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program measure 704 (d) (1134.02, and targets the improvement of water quality and the restoration of riparian areas, holding, spawning and rearing habitats of steelhead spring and fall Chinook and coho salmon

The Confederated Tribes of the Umatilla Indian Reservation are responsible for enhancing stream reaches within the Reservation boundaries as guided by an implementation plan developed cooperatively with the Oregon Department of Fish and Wildlife and the U.S.D.A. Forest Service, Umatilla National Forest.

Treatment areas included three miles of the Umatilla River above the confluence with Meacham Creek where the quality and quantity of holding pool habitat for adult chinook salmon was lacking. Additionally, the lower 4 miles of Meacham Creek were reentered for maintenance of existing instream and flood plain structures and continued structural and riparian vegetation enhancements.

Summer holding habitat for adult salmon was increased and improved through a two mile reach of the Umatilla River. This area has consistently held large numbers of salmon through all or part of the summer. Four mainstem full spanning boulder weirs were constructed and associated holding pools were excavated as needed. Five boulder deflectors were constructed to reduce erosion along a steep cut bank and to create holding pools and improved turbulent holding cover. One boulder control sill was constructed in conjunction with the deflectors to set grade and prevent the continuation of a head wall cut through a section of otherwise stable stream channel. One pine tree and root wad was anchored in-pool to increase cover for holding adult salmon.

Scheduled maintenance and adjustment of existing instream and flood plain structures in Meacham Creek and the Umatilla River was completed. This work was extensive due to spring flooding damage and high bedload movement in the project areas.

Riparian habitats were enhanced with the planting of riparian hardwood cuttings and seeding of disturbed areas with grass seed mix. Livestock was excluded from the confluence of the Umatilla River and Meacham Creek with the construction of 1.5 miles of high tensile fence.

Preparations for future work in Squaw Creek included a cultural resource survey of 14 spring sites, habitat and population surveys of Squaw Creek, and a property line survey for proposed demonstration projects.

Water quality monitoring continued for temperature and turbidity throughout the project area. Survey of channel cross sections and photo documentation of riparian recovery within the project areas provided additional baseline data.

ACKNOWLEDGMENTS

This project was funded by the Bonneville Power Administration. The Confederated Tribes of the Umatilla Indian Reservation thank Jerry Bauer and other Bonneville Power Administration personnel for their assistance. Thanks also to Tim Bailey of the Oregon Department of Fish and Wildlife and John Sanchez and Ed Calame of the Umatilla National Forest for technical input and assistance.

We would like to acknowledge the cooperating landowners who supported our efforts and provided important background on properties in the project areas.

Thanks also to Tribal staff, whose cooperation and contributions are evident in this report. Special thanks to Ken Hall for the long hours inspecting contractors and planting willows, to Gary James for support and guidance, and to Joe Richards for administration of this agreement. For his contribution to the field work, data analysis and report preparation for the Squaw Creek fish habitat and population surveys I thank Paul Kissner.

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INTRODUCTION

This report covers work accomplished by the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) from April 1991 through May 1992 as part of the Umatilla Drainage Habitat Improvement Program. This Program is funded under the Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program, Measure 704 (d) (1) 34.02, as partial mitigation for construction of hydroelectric dams and the subsequent losses of anadromous fish throughout the Columbia River system. The CTUIR as co-managers of the fisheries resources, was identified as the responsible agency for implementation of improvements on the Umatilla Indian Reservation.

The Umatilla River Drainage Anadromous Fish Habitat Improvement Implementation Plan (Implementation Plan), was developed by the Oregon Department of Fish and Wildlife (ODFW), U.S.D.A. Forest Service, Umatilla National Forest (USFS), and the CTUIR to guide enhancement activities in the basin from 1988 through 1992 (Reeve et al. 1988). Enhancement activities target improvement of water quality, and restoration of riparian areas and spawning and rearing habitat of steelhead (Oncorhynchus mykiss), spring and fall chinook salmon (Oncorhynchus tschawytscha), and coho salmon (Oncorhynchus kisutch). These species represent an important cultural and religious resource to the Indian Tribes and their protection is mandated by Treaty with the United States Government.

Enhancement strategies include riparian vegetation restoration and protection, habitat diversity improvement and channel development. Improvements are being implemented in conjunction with other anadromous fish restoration efforts in the Umatilla River Basin including passage improvements (ladders, screens, and flow enhancement) and hatchery suplementation. These efforts will help boost spawning escapement and natural production in the enhanced habitats throughout the Umatilla Basin.

DESCRIPTION OF PROJECT AREA

The Umatilla River is a tributary to the Columbia River at RM 289. It has a drainage basin of 308 sq. miles below the confluence of Meacham Creek(Figure 1). Meacham Creek is a major tributary to the Umatilla River, entering at river mile (RM) 79. It drains approximately 165 square miles and produces 145,000 acre-feet annually at RM 5 near the eastern boundary of the reservation. The principle aquifer is quaternary alluvium composed of unconsolidated sand and gravel, gravel, and some silt. Alluvium may reach a depth of up to 12 feet (Gonthier and Harris, 1975).

The project area includes the lower 4 miles of Meacham Creek, and the Umatilla River between RM 78.5 and 81.7. The lower 4 miles of Meacham Creek and the lower section of Boston Canyon Creek initially treated during previous project years were reentered for maintenance and continued enhancements. The mainstem Umatilla above RM 80 represent an initial entry.

Elevations in the project area range from 1,760 to 2,000 feet above sea level, giving the area an unusually long growing season. Stream gradients average less than 2 percent. Flooding in the project area usually occurs in late winter and spring as a result of a rain on snow event. The flood peaks tend to be high and the volumes large, but the duration of damaging stages seldom last more than a day or two (U.S. Army, Corps of Engineers, 1975).

The project lies in a big game winter grazing zone as outlined by the CTUIR Land Development Code (1983). The primary land use is livestock grazing, May to November. Timber harvest is permissible under a conditional use permit.

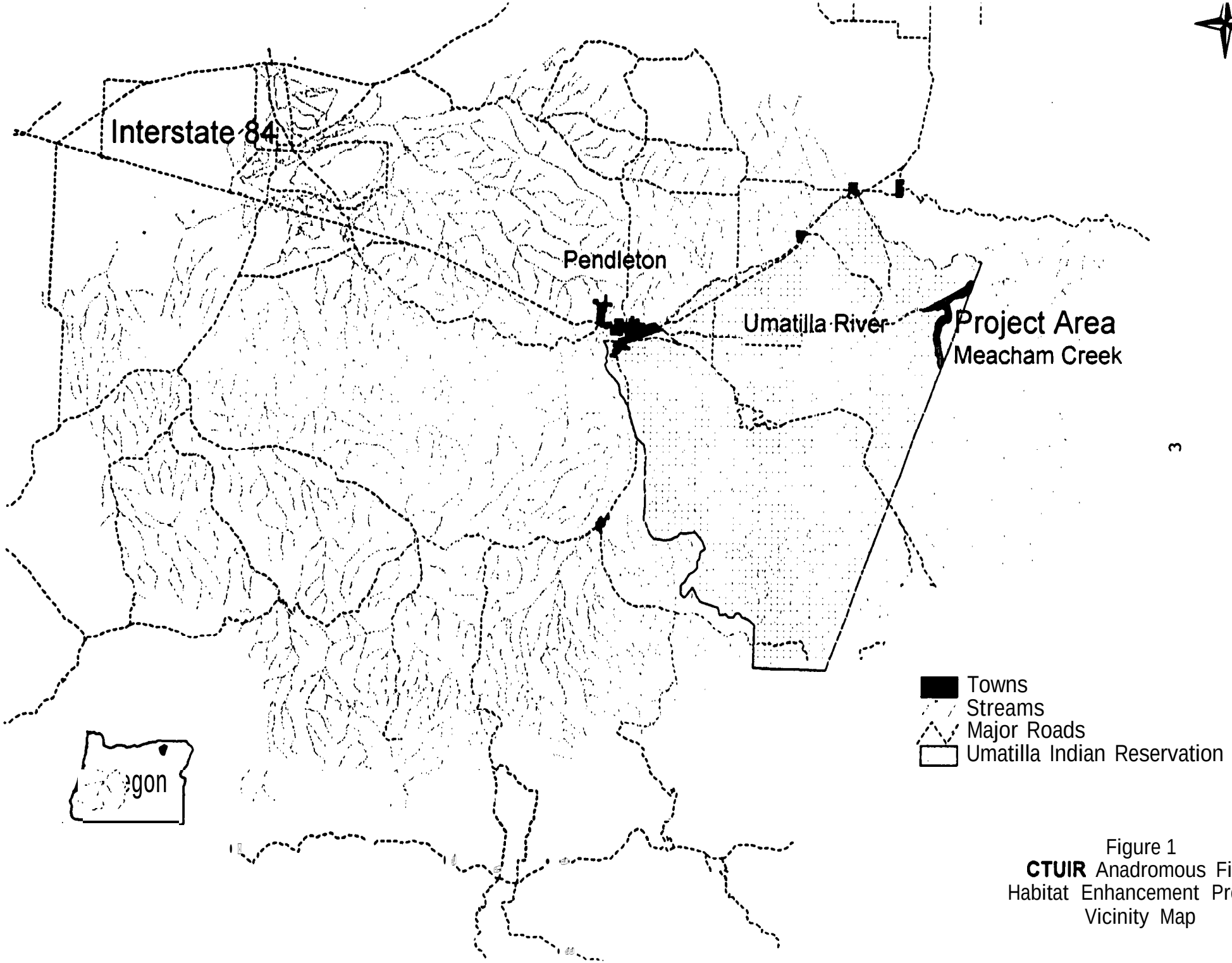

Figure 1
CTUIR Anadromous Fish
Habitat Enhancement Project
Vicinity Map

METHODS AND MATERIALS

Project Design and Layout:

Spring Chinook pre-spawning surveys of the Upper Umatilla River were conducted in previous years to assess the quality and quantity of adult holding water throughout the holding season. Existing pools were predominantly lateral scour and plunge pools created in constricted channels and below bedrock shelves. All large pools were found to be lacking in instream hiding cover and by the end of the summer were reduced in both area and depth as a result of dropping summer flows. This situation subjected holding adults to increased disturbance from swimmers and trout fishers and made them highly vulnerable to predators and poachers.

CTUIR staff conducted preliminary surveys of the upper three miles of Umatilla River above Meacham Creek on the Reservation for potential pool enhancement opportunities. Four sites were selected that exhibited significant natural pool scouring capability, a high level of stream bank stability, potential for enhancement and available access for equipment and materials. One additional site was identified where adult holding pools could be integrated into stream bank and bed stabilization structures.

The CTUIR contracted with James M. Montgomery Consulting Engineers of Idaho (JMM) for the assessment of site specific and basin hydraulic conditions, development of design criteria, materials specifications and volumes estimates, and preparation of construction ready design of instream structures in the mainstem Umatilla River. CTUIR and JMM staff surveyed five proposed structure sites to confirm preliminary site suitability determinations. All sites were found to be suitable for instream drop structures and the decision was made to proceed to conceptual design stage.

Structure designs and material specifications were developed to provide function and stability throughout the full range of flows expected at the sites. A design velocity appropriate for fish passage, scour action and increased surface turbulence was selected for low flows and annual runoff conditions. Structures were designed to maximize scour during mean high flows (1135 cfs) with a minimum velocity of 10 feet per second. During mean low flow periods (35 cfs) high surface turbulence and acceptable fish passage would be maintained with a maximum velocity of 10 feet per second.

Surveys for maintenance needs of existing project areas on Meacham Creek and the Umatilla River were conducted by CTUIR staff following a high flow event on May 12, 1991. Equipment and materials needs were estimated.

Machine access and haul routes to structure sites and materials storage sites were identified and flagged by tribal staff. Construction staking at structure sites and was completed by JMM.

Landowner Agreements:

Riparian condition and stream bank stability at the four weir sites was excellent. This was due in large part to the natural valley bottom configuration and generally good land use practices. Land use is dominantly for rural and recreational dwellings. Livestock grazing is nonexistent with the exception of periodic trespass. As such, riparian corridor easements with associated costs of fencing were not considered necessary. Access agreements were developed with four owners of fee lots and four owners of a BIA trust allotment that gave permission to construct and maintain the enhancements as needed. The fifth site was located within an existing conservation easement area on trust land.

Existing agreements on Meacham Creek and the Umatilla River ensured access for maintenance and continued enhancements as needed.

Instream Permits:

Permit applications were submitted to and permits granted from the Army Corps of Engineers for 404 Fill and Removal Permit and the CTUIR Department of Natural Resources for Tribal Stream Zone Alteration Permits.

Subcontracts:

The CTUIR prepared, advertised and awarded for bids and requests for proposals for the various materials delivery, survey and construction activities associated with future project planning and the construction of instream and flood plain structures as follows:

Hydraulic Engineering and Design of Mainstem Structures

The CTUIR contracted with James M. Montgomery Consulting Engineers of Idaho (JMM) for the assessment of site specific and basin hydraulic conditions, development of design criteria, materials specifications and volumes estimates, and preparation of construction ready design of instream structures in the mainstem Umatilla River.

Equipment Rental For Instream Construction

Sub-contract for rental of operated equipment for materials movement and instream construction and maintenance was awarded to Harney County Gypsum Co., of Burns Oregon.

Fence Construction

Sub-contract for construction of high tensile fence was awarded to Raymond Doherty of Pilot Rock Oregon for the construction of 1.5 miles of fencing on the Umatilla River and lower Meacham Creek

Cultural Resource Surveys for Squaw Creek

Sub-contract for cultural resource survey of spring sites in the Squaw Creek Basin proposed for protection and development was awarded to Burney and Associates of Boulder Colorado.

Property Line Survey for Squaw Creek

Sub-contract for property line survey of demonstration project area in the Squaw Creek Basin was awarded to William R. Wells Land Surveying and Planning of Pendleton Oregon.

Materials (Boulders and Rip Rap)

Rock for instream and flood plain structures was purchased at a delivered price from Humberts Excavating of Milton-Freewater Oregon.

Monitoring and Evaluation:

Stream Channel Cross Sections

Stream channel cross secticns were measured on the mainstem Umatilla River structures at 40 foot intervals above, within, and below each structure site as part of the initial structure design analysis. Permanent cross section monitoring points were deveioped at these locations for post construction monitoring. Cross sections at past project areas on the Umatilla River and Meacham Creek were surveyed to document ongoing channel movements. A total of 51 post construction cross sections were surveyed by tribal staff.

Photo Documentation

Photc documentation of riparian recovery and instream structure f-unction over time was ccmpleted at all cross section locations and at selected pre-established permanent sites using 35mm slide film. Slides were cataloged in the CTUIR Photo record library.

Squaw Creek Habitat Surveys

Past spawning ground surveys have shown Squaw Creek to be a major producer of steelhead in the Upper Umatilla Basin. Baseline data on fish abundance and habitat conditions were needed for out year project planning. Salmonid populations were estimated and length frequencies documented in Squaw Creek from the Umatilla River at the mouth upstream to Little Squaw creek using multiple pass electrofishing or Peterson mark-recapture. A modified Hankin and Reeves methodology was used to estimate fish habitat areas during July and August when low stream flows are believed to limit habitat capability. This data is summarized in Appendix B.

Water Quality Monitoring

Temperature and sediment data was collected as an ongoing part of the restoration efforts. Water temperatures were recorded hourly using hydrothermographs at various locations on Meacham, Squaw, Buckaroo, and Wildhorse Creeks and the Umatilla River (Appendix A).

Sediment load was monitored from May 1 through November 30, 1991 using ISCO sediment samplers on the Umatilla River and Meacham Creek (Appendix A).Samplers were removed prior to high flows to prevent possible damage or loss.

Riparian Enhancements:

Riparian habitats were enhanced through the planting of local stock riparian hardwood cuttings and seeding of gravel bars and disturbed sites with grass seed/forb mix. A total of 1000 lbs of seed mix was planted. This occurred primarily during spring and fall with limited seeding of haul roads during the summer months. Approximately 1500 willow cuttings were prepared and planted during the spring and summer months.

Instream Construction:

Summer holding habitat for adult salmon was increased and improved though a two mile reach of the Umatilla River. This area has consistently held large numbers of salmon through all or part of the summer. Contacts made with landowners that live along the river has increased awareness of the vulnerability of the holding adult salmon and should provide for improved security.

Instream and flood plain habitat enhancements constructed in previous implementation years in the lower four miles of Meacham Creek and the Umatilla Rivern betwee RM 78.5 and 80, were maintained and modified to meet their original design functions. Where appropriate, additional structures were built and large organic materials anchored to increas instream cover. Long term stability of instream structures was increased though cabling structures together using the Hilti Fastening System. These efforts should ensure continued increases in stream channel stability and habitat capability for cold water anadromouse fish.

All instream activities were directed and inspected by tribal habitat staff. Petroleum absorbent booms were deployed downstream of all heavy equipment working in the stream zone to protect against spills of petroleum products from engine and hydraulic systems.

RESULTS AND DISCUSSION

Habitat Enhancements:

Four mainstem full spanning boulder weirs were constructed and associated holding pools were excavated as needed. Five boulder deflectors were constructed to reduce erosion along a steep cut bank and to create holding pools and improve turbulent holding cover. One boulder control sill was constructed in conjunction with the deflectors to set grade and prevent the continuation of a head wall cut through a section of otherwise

stable stream channel. One pine tree and root wad was anchored in-pool to increase cover for holding adult salmon.

Scheduled maintenance and adjustment of existin instream and flood plain structures in Meacham Creek and the Umatilla River was extensive due to high spring flooding and the resulting bedload movement. These activities including the following:

Reset parts of 5 revetment walls; repaired 23 deflectors; relocated 5 deflectors; repaired 3 boulder weirs; reset 30 thalweg and turning boulders that had been inundated with bedload; reset 5 boulder wing controls; replaced 100 ft of boulder toe revetment; built three new boulder deflectors; placed and anchored 10 stree instream for cover and revetments; and used over 300 Hilti placements to increase structure stability over time.

Riparian area recovery was enhanced throughout the Meacham Creek and Umatilla River project areas with the planting of grass/forb seed mixes and riparian hardwood cuttings on sites disturbed by high stream flows and/or construction activities. Success of these plantings appeared to be more dependent on water table than season of planting. Channel bedload scour and deposition removed or buried many of the cuttings. These efforts will provide for increased stream bank stability and maintenance of lower water temperatures within and below the project areas. Additionally, riparian corridors at the confluence of the Umatilla River and Meacham Creek were protected through the construction of 1.5 miles of high tensile smooth wire fencing to exclude livestock.

Monitoring and Evaluation:

Monitoring and evaluation o instream and riparian recovery continued throughout all project areas with photo-documentation of riparian recovery, survey of 51 channel cross sections to measure the effects of treatments on stream channel morphology, and collection of water temperature and sediment loading data. While the effects of the enhancement efforts on water quality may not be detectable for years, the data collected will provide important base line information.

Hydrothermographs were housed either in submersible cases or in weather proof cases with external sensor cables. The success of the later was significantly effected by damage to the external sensor cables by beaver. In applications where these cables were completely housed in metal pipe, there was no recorded damage. However, in applications were the cable was left partially or completely exposed, and in at least one situation where the cable was entirely buried at time of deployment, beaver damage resulted. Loss or corruption of data was significant. Future applications of these external sensors will be reserved for fully housed sites.

Squaw Creek Fish Habitat Survey Summary:

Results of the modified Hankin/Reeves methodology for estimating habitat area (Table 1) show values for July and August of 1991. Water levels continued to fall through September and October when the population estimates were made. The importance of instream cover, water quality and pool size became apparent in October while conducting the population surveys as many pools were either lost or left barren of fish due to predation or lethal water temperatures.

Table 1. **Total number of units(N), number of units accurately measured (n), sample-based estimates of ratios of accurately measured areas to visually estimated areas (Q), estimated total areas (ft') of all units (M), estimated total volume (ft3) of all units (&), estimated variances for estimated total areas (V(M)),and 95% confidence bounds for estimated total areas (95% C.I.) for pools and riffles of Squaw Creek during July and August of 1991.**

POOlS						
N	n	Q	M	Mv	V (Ml	95% c-1.
234	31	0.946	142,390.5	74,030.89	33,617,880.48	11,596.19
Riffles						
236	30	. 0929	1349,084.8	67,992.95	193,631,269.4	127,830.29

Out-Year Planning:

Planning for out-year habitat enhancements in the Squaw Creek Sub-basin included the survey of property lines for a proposed demonstration project area. Tax lot maps showed the western boundary of the property to follow a logical fence location along a rock bluff. However, the survey located the boundary of the proposed project area within the unstable stream channel bed for most of its length. This precluded the construction of a fence to exclude livestock and therefore made a demonstration project at this location impractical. Efforts to locate a suitable property will continue.

Spring sites throught the Squaw Creek watershed contribute critical high quality water to late season stream flcws. A cultural resources survey of 14 spring sites was conducted as a prerequisite to developing and protecting these sites. Historic and prehistoric sites were located in the course of this investigation. These finds were repcrted to the State Historic Preservation Office in a report titled 'A Cultural Resource Inventory of Fourteen Spring Sites Located In The Squaw Creek Vicinity Southeast Of Thorn Hollow Confederated Tribes cf the Umatilla Indian Reservation,Mission, Oregon'(September 12, 1991). This information will enable the CTUIR to take actions to help ensure the protection of cultural resources during construction activities at the spring sites. The information will also be incorporated into the programmatic Environmental Assessment of spring site developments on the Umatilla Indian Reservation being conducted by the Umatilla Agency, Bureau of Indian Affairs. Development of these and other spring sites in the Umatilla Indian Reservation wiil be postponed pending completion of this document.

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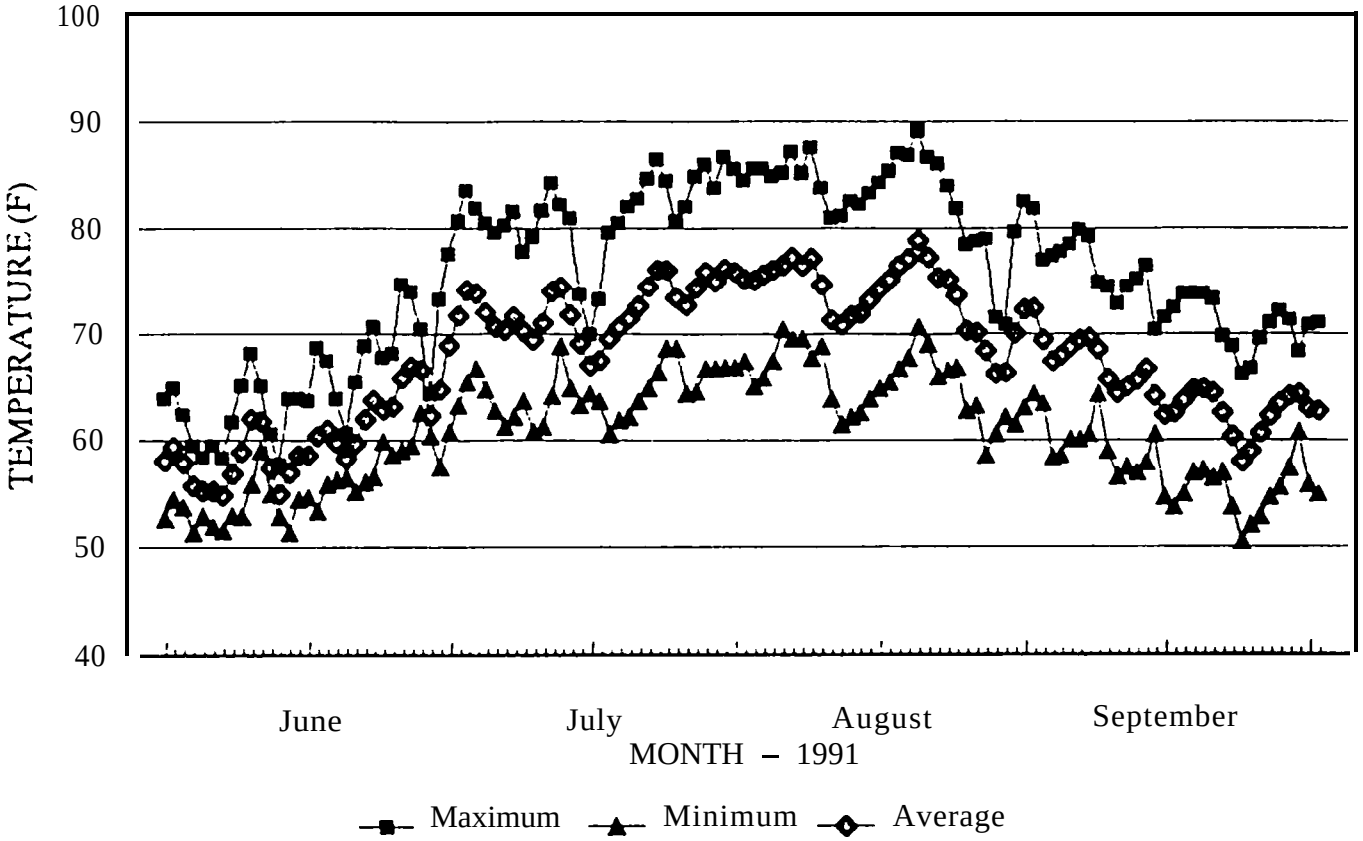
Appendix A:

Water Quality Data

UMATILLA RIVER

River Mile 56 (West Reservation Boundary)



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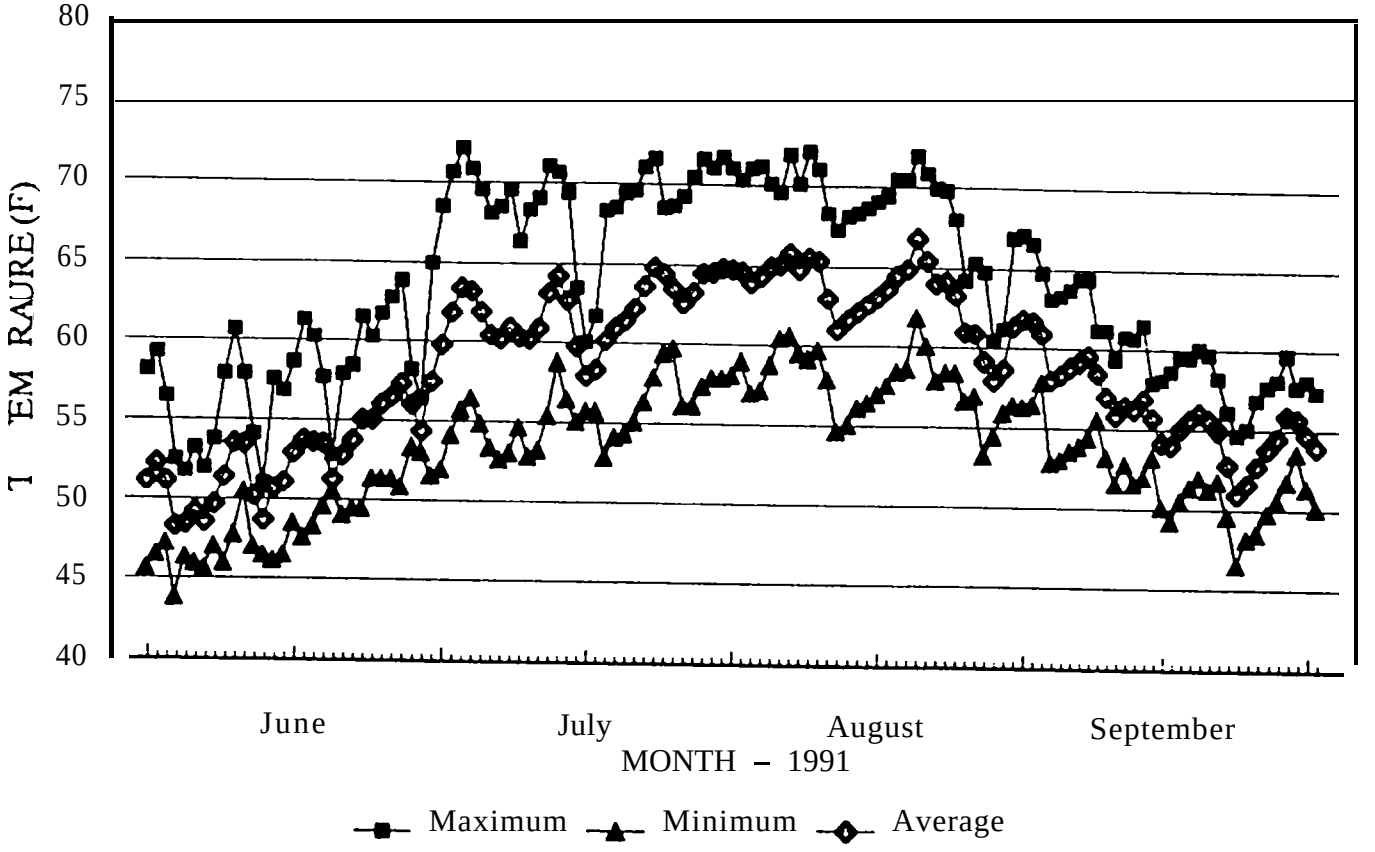
UMATILLA RIVER

River Mile 79 (Upstream Mouth of Meacham Creek)



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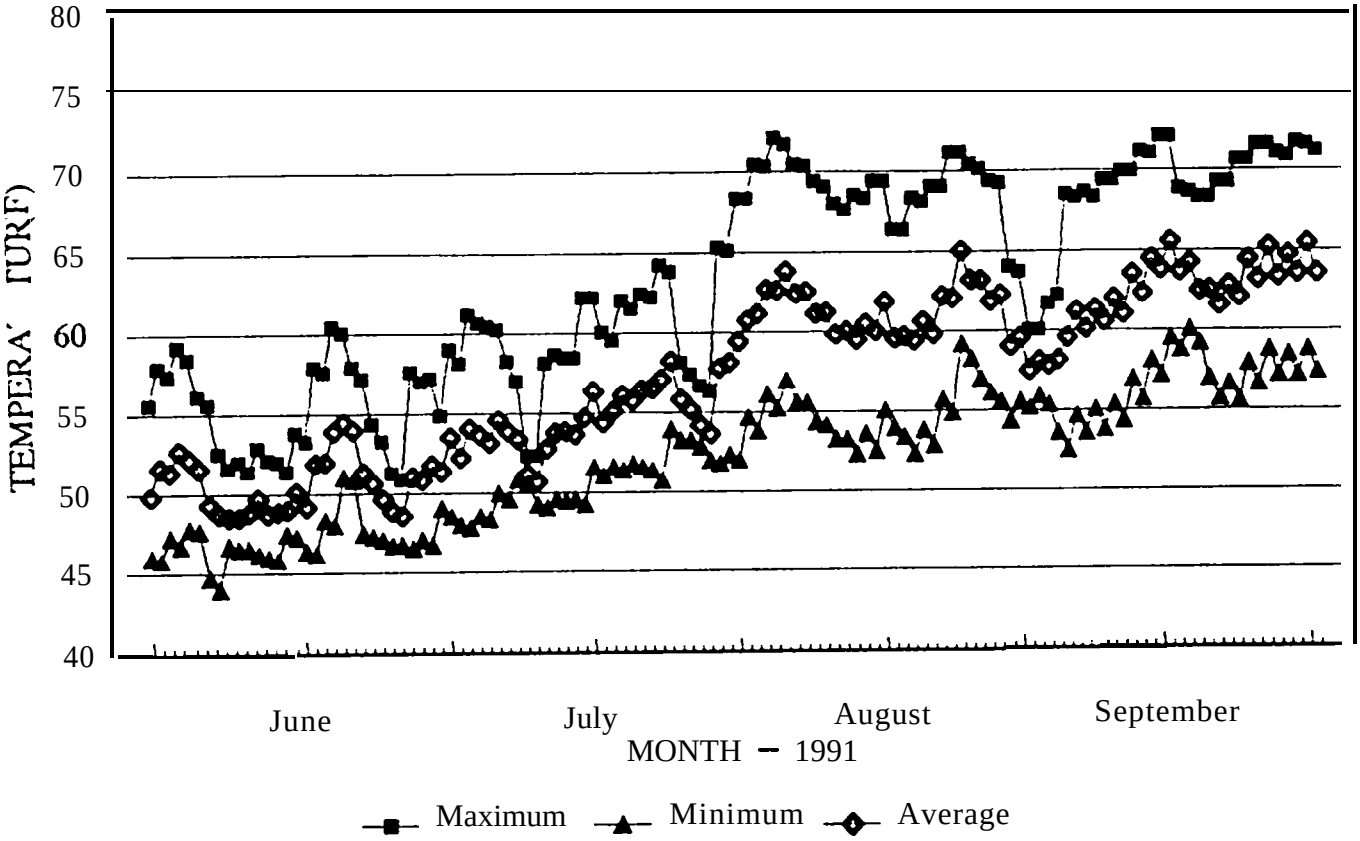
UMATILLA RIVER

River Mile 81.7 (USGS Gage Station)



File Name TL902391.002
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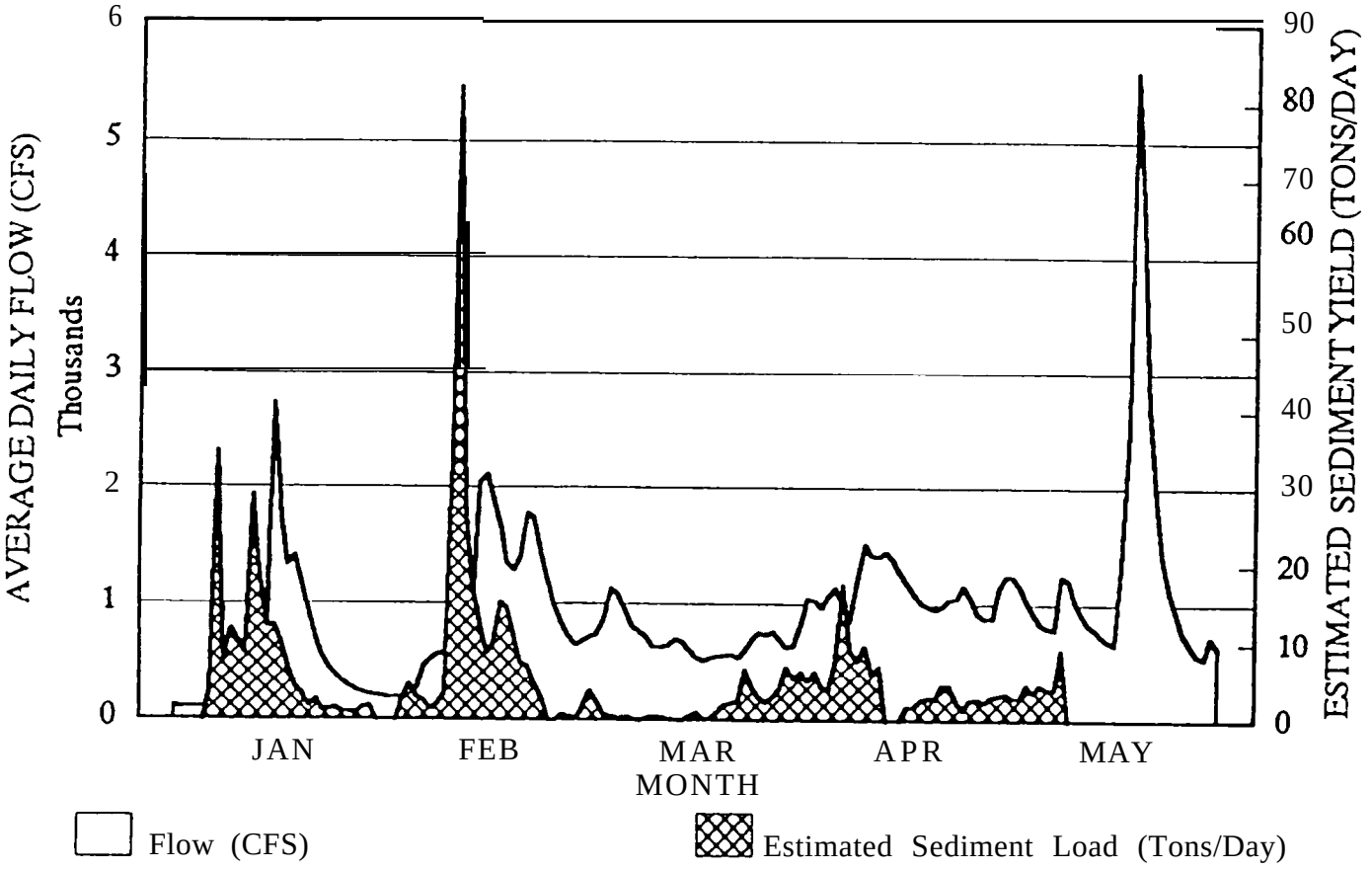
1991 UMATILLA RIVER SUSPENDED SEDIMENT DATA

River Mile 78.5 (Downstream Mouth of Meacham Creek)

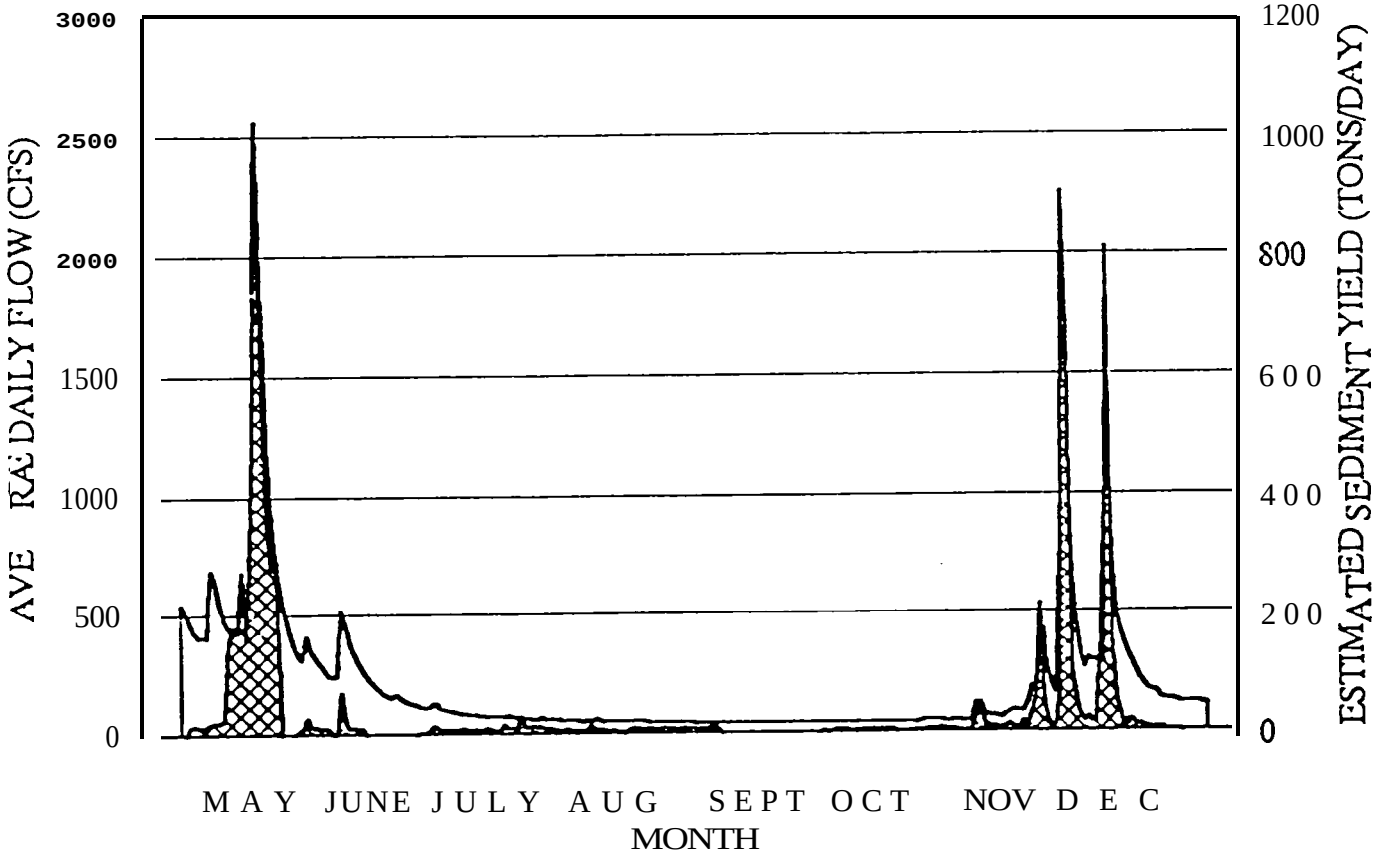


Sediment data not collected January 1 through January 8 and May 12 through May 31.
Flow collected @ Umatilla River Mile 81.7 and Meacham Creek River Mile 2

File Name: MIDUMA91
Graph File Name: BELOWMEA

1991 UMATILLA RIVER SUSPENDED SEDIMENT DATA

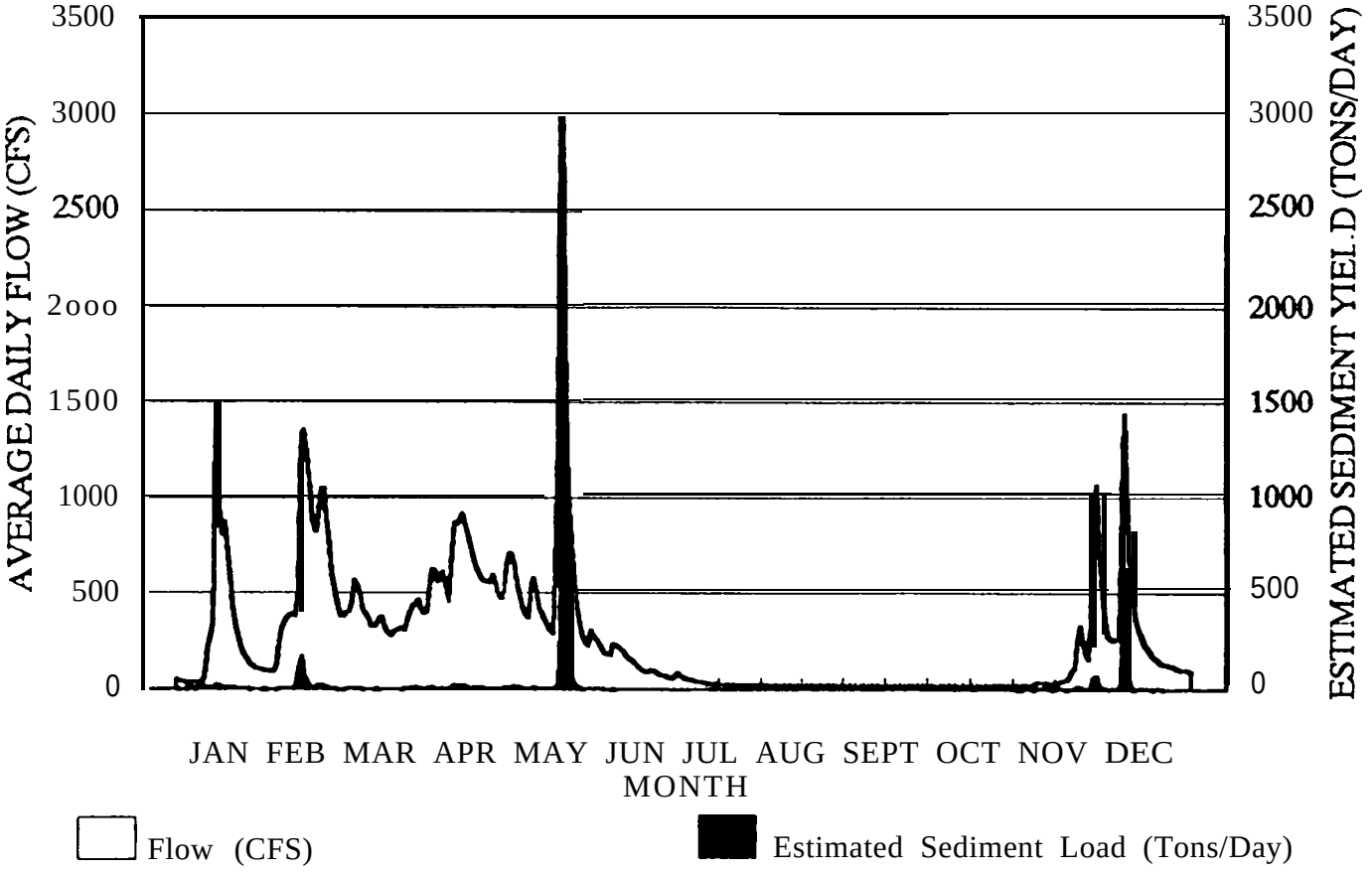
River Mile 81.7 (USGS Gage Station)



Sediment data not collected June 13 through June 25.

File Name: UPUMA91
Graph File Name: UMASED91

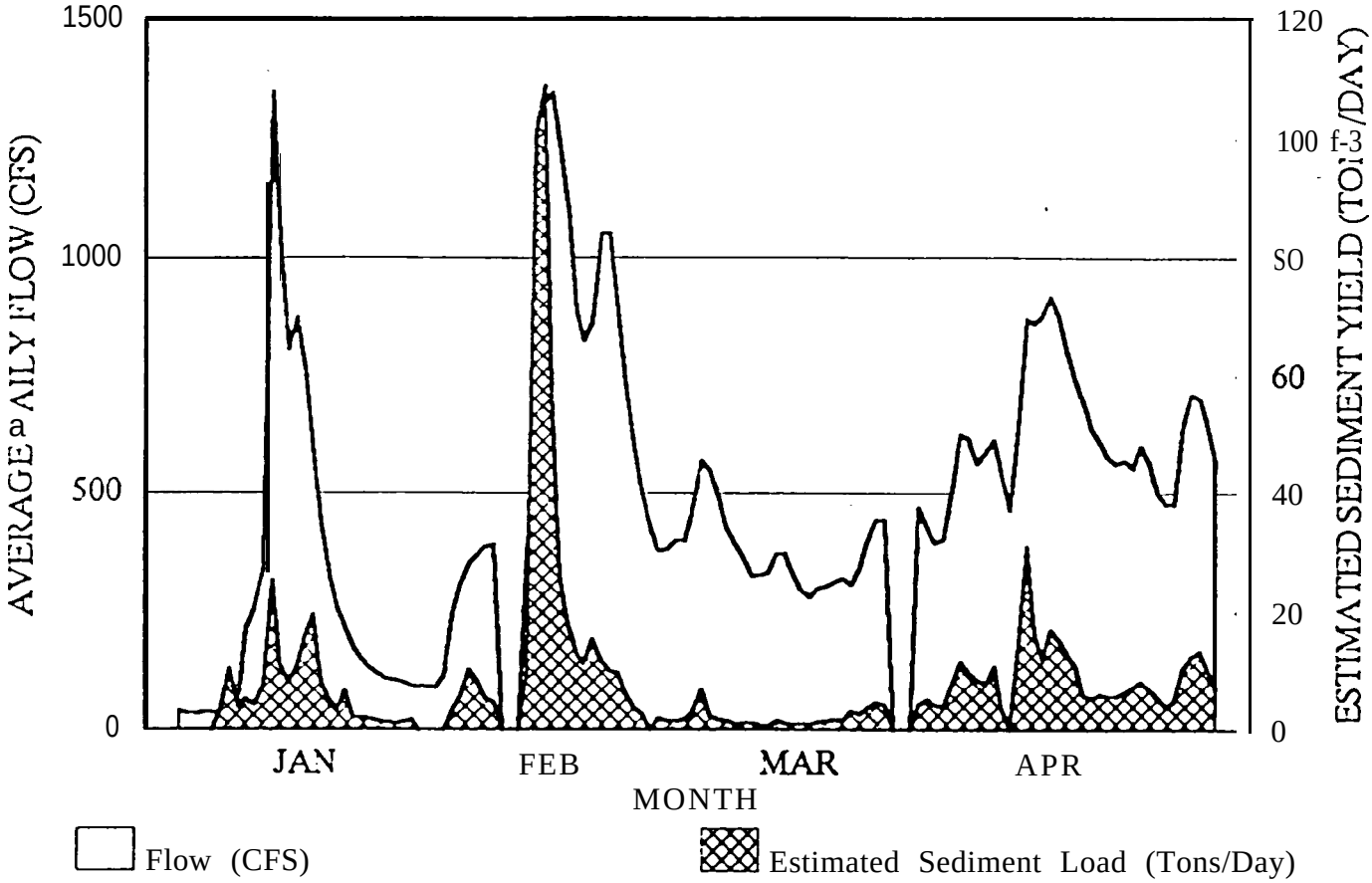
1991 MEACHAM CREEK SUSPENDED SEDIMENT DATA
River Mile 2 (USGS Gage Station)



File Name: MEAGRAPH
Graph File Name: MEA9lSED

1991 MEACHAM CREEK SUSPENDED SEDIMENT DATA

River Mile 4



Sediment data not collected January 1 through January 8.

Sediment data collected @ River Mile 4. Flow data collected @ River Mile 2

File Name: MEARM491

Graph File Name: M4SED91

Appendix B:

Fish Habitat/Population Data

Squaw Creek Juvenile Rainbow/Steelhead Population Estimates, October 1991.

Objective: To estimate the population of juvenile rainbow/steelhead by age class in approximately 10% of the pools and riffles in Squaw Creek, from the confluence with the Umatilla River upstream to the confluence with Little Squaw Creek.

Procedures: Population estimates of age 0+ and 1+ rainbow/steelhead were conducted on approximately 10% of the pools and riffles in Squaw Creek from the confluence with the Umatilla River upstream to Little Squaw Creek during October 1991. Units sampled were selected systematically after randomly determining the first pool and riffle to be sampled. Three methods of estimating populations were utilized. If the pool or riffle to be estimated was wide or had cover, the Peterson mark-recapture procedure was utilized and if little or no cover and a narrow channel, where fish would have difficulty avoiding the electrical field, a single pass or multiple pass was made. The objective of multiple pass was to catch and remove all fish. One small open pool with no cover was visually estimated as placement of the block nets could not have been accomplished without "spooking" the fish from the hole.

Block nets were utilized to keep fish from immigrating to or emigrating from the area being estimated. Because of the small size of the stream, sections to be shocked were approached from the ends to place the block nets to avoid disturbing the fish.

It appeared that the following basic assumptions which are necessary when conducting a Peterson mark-recapture population estimate, were valid during the study.

(1) marked fish are recognized as marked on recapture
(2) marked fish randomly distributed
(3) marked and unmarked fish are equally susceptible to recapture
(4) no movement of fish into or out of area being estimated

Initially, juvenile rainbow/steelhead and chinook salmon were anesthetized with MS222, marked by removal of approximately 1/4mm of the lower edge of the caudal fin and released. After several minutes the fish recovered from the anesthetic but often hugged the bottom at the release sites until disturbed. Because of the time it took the fish to recover, and thus randomly mix with the population, anesthetic use was discontinued after the first several days.

Fork lengths and scales were collected for age, length relationships. Scales were collected from the preferred area.

Results: Population estimates were completed on 20 of 233 pools (8.6%) and 19 of 235 riffles (8.1%) in the study area. Peterson mark-recapture estimates were utilized to conduct population estimates on 12 pools and 3 riffles, multiple pass on 5 pools and 2 riffles, single pass on 1 pool and 12 riffles and direct observation on 2 pools and 2 riffles (Appendices A & B).

Population estimates of rainbow/steelhead juveniles in pools varied between O-l 17 age 1 + or older and O-28 age O+. Eliminating pools that had been dewatered, an average of 33.6 age 1 + and 3.6 age 0+ rainbow/steelhead occupied the sampled pools in October of 1991 (Table 1.)

Population estimates of juvenile rainbow/steelhead in riffles varied between O-53 for age 1 + or older and O-83 age 0+ rainbow/steelhead. Eliminating riffles that had been dewatered, an average of 16 age 1+ and 13.2 age 0+ juvenile rainbow/steelhead occupied the sampled riffles during October of 199 1.

Population estimates based on single or multiple pass electrofishing were more accurate for age 1 + and older rainbow/steelhead, as young-of-the-year rainbow/steelhead would often dive nose first into the substrate, where they were extremely difficult to observe and retrieve. For example, riffle 95 was estimated by single pass electrofishing on October 10, 1991 and 36 young-of-the-year and 43 age 1+ or older rainbow/steelhead were enumerated. A Peterson mark-recapture estimate was conducted the following day and 83 young-of-the-year and 48 older age rainbow/steelhead were estimated to be present. Thus we feel that population estimates in Squaw Creek riffles (where single or multiple pass electrofishing was utilized) seriously underestimated the number of young-of-the-year present, but were reasonably accurate in estimating the number of age I+ or older rainbow/steelhead Considerably more time would have been required to conduct a Peterson mark-recapture estimate on the riffles that were single pass electrofished.

The number of juvenile rainbow/steelhead inhabiting Squaw Creek riffles under average flop conditions (November-May) would probably be much higher than was observed during the October population estimates that were conducted at low flows. Conversely the number of rainbow/steelhead inhabiting pools would probably be lower than we observed. Because of the low flows, rainbow/steelhead in many areas were forced into refuge pools, as riffles lowered or dried up. Flow conditions in Squaw Creek were generally normal during June-October 1991.

To determine length frequency vs. age of rainbow/steelhead in Squaw Creek, fork lengths and scales were randomly collected on October 16-18, 199 1 throughout Squaw Creek, below its confluence with Little Squaw Creek. The rainbow/steelhead sampled in Squaw Creek ranged from 66-255mm fork length and three age classes were present. Age 0+ young-of-the-year rainbow/steelhead ranged between 67.5mm and 102.5mm fork length and averaged 85.7mm fork length. Age 1+ fish ranged between 97.5mm to 182.5mm fork length and averaged 127. lmm fork length. Age 2+ fish ranged from 194 to 255mm fork length and averaged 228mm fork length (Table 2).

Sections of Squaw Creek throughout the area from Little Squaw Creek to the confluence with the Umatilla River were completely dewatered at times between July 16 and October 17, 1991. Population densities were highest in deep holes; especially if abundant cover was present, and

in bedrock holes and riffles with large boulders and good flow. Rainbow/steelhead were also abundant in shallow pools if overhanging vegetative cover was also abundant. Pools and riffles that lacked cover (boulders, large and small organic debris, deep water) generally had lower densities of rainbow/steelhead unless large areas were dewatered immediately above a pool and fish were obviously seeking a low water refuge.

Juvenile rainbow/steelhead stranded in certain pools, mostly in the upper mile below Little Squaw Creek, where the gradient is steepest, experienced 100% mortality as pools dewatered during July- October. Because of the low water conditions prevalent in Squaw Creek during this period, juvenile rainbow/steelhead were also very vulnerable to predation. Kingfishers and water pipets were observed diving and taking fish, and mink tracks were numerous along pool margins.

A total of 95 young-of-the-year chinook salmon were estimated in the pools sampled and one chinook salmon young-of-the-year in riffles. They were distributed from just below Little Squaw Creek to lower Squaw Creek. Densities of young-of-the-year chinook salmon were very low throughout the areas sampled, compared to levels observed in the upper Umatilla mainstem and North Fork of the Umatilla River.

Other fish species captured in order of abundance in Squaw Creek include shiners, dace, squaw-fish and sculpins.

Several recommendations to increase juvenile rainbow/steelhead survival based on observations conducted during the July-October of 1991 are as follows:

(1) Placement of structure (large and small organic debris) in pools would increase survival by providing escape cover from predators.

(2) Juveniles could be moved to the deeper bedrock pools that do not dewater, especially in the upper several miles below Little Squaw Creek.

Table 1. Squaw Creek juvenile rainbow/steelhead and chinook salmon population estimates conducted on 20 pools and 19 riffles. October. 1991.

	Age 0+ Rainbow/Steelhead				Age 1 + or older Rainbow/Steelhead				Age 0+ Chinook			
	n	$\bar{X}$	Range	S.D.	n	$\bar{X}$	Range	S.D.	n	$\bar{X}$	Range	S.D.
Pool	69	3.6	O-28	6.2	639	33.6	O-117	30.0	95	5	O-34	8.8
Riffle	211	13.2	O-83	20.1	256	16.0	o-53	15.6	1	.06	O-l	.3

Table 2. Fork length vs. age of Squaw Creek rainbow/steelhead, October 16-18, 1991.

Fork Length (mm)				
Age	n	Range(mm)	Mean(mm)	S.D.
o+	47	67.5-102.5	85.7	8.6
1+	174	97.5-182.5	127.1	17.2
2+	4	194-253.5	228.0	26.3

Appendix A. Squaw Creek salmonid population estimates, October, 1991.				
Riffle #	Age 0+ Rainbow/Steelhead	Age 1+ or older Rainbow/Steelhead	Age 0+ Chinook	Estimation Method and Observations
R3	0	0		Visual-Dry
R8	6	0	1	Multiple Pass
R13				7RB - no age data Multiple Pass
R35	3	0		Single Pass
R55	16	20		Peterson
R85	7	14		Single Pass
R95	83	48		Peterson
R105	11	3		Single Pass
R125	24	53		Peterson
R135	24	9		Single Pass
R145	7	18		Single Pass
R155	6	16		Single Pass
R165	0	0		Single Pass
R185	1	13		Single Pass
R195	13	28		Single Pass
R205	1	9		Single Pass
R215	1	8		Single Pass
R225	0	0		Visual-Dry
R235	8	17		Single Pass
	n=211	n=256	n=1	

Appendix B. Squaw Creek salmonid population estimates, October 1991.

Pool #	Age 0+ Rainbow/Steelhead	Age 1+ or older Rainbow/Steelhead	Age 0+ Chinook	Estimate Method and Observations
P5	28	36	19	Peterson
P10	5	34	3	Peterson
P15	3	0	1	Multiple Pass
P33	0	37	34	Peterson
P43	1	10	0	Multiple Pass
P45	1	27	1	Peterson
P53	0	59	3	Peterson
P63	1	59	12	Peterson
P93	1	42	1	Peterson
P103	6	117	0	Peterson
P113	3	8	0	Visual
P123	4	5	0	Single Pass
P143	3	26	1	Peterson
P153	2	41	3	Peterson
P163	1	23	0	Peterson
P183	5	34	13	Multiple Pass
P203	5	20	4	Peterson
P213	0	40	0	Multiple Pass
P223	0	0	0	Visual-Dry
P233	0	21	0	Multiple Pass LSC
	n=69	n=639	n=95	

Squaw Creek rainbow/steelhead length

frequency Oct.16-18,1991 (n=221)